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Lean Six Sigma Journey in a UK Higher Education Institute: A Case Study

Abstract

Purpose - The purpose of this paper is to explore the fundamental challenges and critical success factors (CSFs) in the development of a Lean Six Sigma (LSS) initiative within a UK Higher Education Institute (HEI). The paper also illustrates examples of the types of projects completed and share some of the key lessons learned as part of the LSS journey.

Design/Methodology/Approach – The authors have initially carried out an extensive literature review on the application of LSS in Higher Education to understand the existing body of work carried out by other scholars in the field. This is followed by presenting a case study explaining how a Higher Education Institute in the UK has embarked on its LSS journey as a process excellence methodology to improve the efficiency and effectiveness of core and supporting business processes.

Findings – There has been a clear lack of support and commitment from senior management in the sustainability of LSS within the case study organisation. There was a general lack of understanding of the benefits of LSS in the Higher Education context and there is a lack of knowledge on the use of LSS tools for tackling process efficiency and effectiveness problems across the case study organisation. Although a number of LSS projects were executed across finance, administrative, and human resources, as well as IT and library services, no projects were carried out for improving academic processes such as teaching effectiveness.

Research limitations – As the case study is limited to one Higher Education Institution, the findings of the study cannot be broadly generalized. Moreover, the paper does not report the findings of any strategic projects as most projects were carried out at the operational level.

Originality/Value – This is possibly one of the first studies reporting project examples of Lean Six Sigma in a HEI. The results of the study can also be used to benchmark with similar studies in other HEIs to understand the impact of certain management practices of LSS.

Key words- Lean, Six Sigma, Lean Six Sigma, Process Excellence, UK Higher Education

Paper type- Case study

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Introduction

The last two decades have witnessed an increased pressure from customers and competitors for greater value from their purchase whether based on superior quality, faster delivery, or lower cost (or a combination of all three) in both manufacturing and service sectors (George et al., 2005). Lean is a powerful business process improvement methodology to minimize or even eliminate different forms of waste or non-value added activities. Six Sigma, on the other hand, focuses on the critical to quality (CTQ) characteristics in processes and aims at reducing cost by reducing defect rates due to excessive process variability and achieving superior consistency in performance (Manville, 2012). Any organization applying Six Sigma to reduce variation from its business processes will, after a certain period of time, realize that the benefits begin to fall. Similarly, any organization applying Lean will notice a gradual decline in the returns after a certain period of time. Reducing waste alone using Lean thinking cannot improve the process stability and capability entirely and similarly reducing variation using Six Sigma thinking still leaves behind waste in business processes; moreover, speed losses in processes cannot be tackled effectively (Amheiter and Maleyeff, 2005).

Lean theory proposes that work processes should be designed as a single, continuous flow containing all of the steps that incrementally add value in the eyes of the customer(s) and take the product or service from source to completion (Nash and Poling, 2008). In a manufacturing context, Taiichi Ohno from Toyota sees the essence of Lean as being a system that is able to produce goods, at the rate driven by customer demand, in an uninterrupted continuous flow with minimum spare capacity (Ohno, 1988). In a service context, McBride (2007) states that the delivery of services differs from manufacturing in that it consists of not only what the organization does but also, more significantly, what the customer does. George (2003) argues that service industries can reap huge benefits from the Six Sigma approach. Many service-oriented companies still conform to the notion that Six Sigma is confined just to manufacturing or production related environments. The best way to convince a service-oriented company to initiate, develop, and implement the Six Sigma strategy is through the three rudimentary principles (process thinking, data driven and variation) of statistical thinking advocated by Hoerl and Snee (2002).

The basic goal of the Six Sigma strategy is to reduce variation within the tolerance or specification limits of a service performance characteristic. In order to improve the quality of a typical service, it is imperative to measure or quantify variation and then develop potential strategies to reduce variation of service performance characteristics such as waiting time, time to resolve customer complaints, and turnaround time to process applications. The key benefits of Six Sigma in service related organisations are well reported by Antony (2006).

Lean does not look at variation within a business process, rather it addresses variation (in the form of waste) between processes. In other words, lean is primarily beneficial in understanding the flow of various steps or sub-processes from start to finish of a process and reduces various types of waste in the process (Antony, 2011). Lean Six Sigma can benefit from lean thinking, particularly in the areas of elimination of waste and acceleration of process flow. Moreover, Lean Six Sigma can benefit from Six Sigma thinking, particularly in tackling problems with unknown solutions or

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chronic business problems where the previous solutions have not been effective. For these reasons, practitioners of Lean and Six Sigma started to develop the thinking towards a merger of the two approaches and Lean Six Sigma (LSS) was born (Snee, 2010).

The key point is that organizations need to avoid having "favourite" methods that they apply to all problems, even if the method is not suited for that particular problem. Integrating Six Sigma and Lean into a broader approach called Lean Six Sigma has enabled many organizations, including GE, Honeywell, Cummins, Caterpillar, and Bank of America to name a few, to solve more problems quicker and enhance the bottom line faster. It can be considered state of the art in improvement at the time of this writing. The integration of Lean and Six Sigma methodologies provides organizations with the methods, tools, and techniques for superior improvements (Fitzpatrick and Looney, 2004). Lean Six Sigma is a powerful methodology for achieving process efficiency and effectiveness resulting in enhanced customer satisfaction and improved bottom line results.

Leaders enable an organization to move from one paradigm to another; from one way of working to another way of working. In making these shifts, work processes of all kinds get changed. Lean Six Sigma provides the concepts, methods, and tools for changing processes. The objective of Lean Six Sigma is to transform organizations from separate reactive operations, which are generally functionally oriented, into cross-functional process-focused organizations. According to Swartling (2011), coordinated quality approaches reap significant improvements over stand-alone project approaches. Lean Six Sigma is an effective leadership development tool in that it prepares leaders for their role, leading change (Snee, 2010).

The benefits of Lean Six Sigma in the industrial world (in both manufacturing and services sectors) have been highlighted extensively in the literature (Zhang et al., 2012) and include the following (Antony, 2005; Antony, 2006).

1. *Ensuring services/products conform to what the customer needs (voice of the customer)*
2. *Removing non-value adding steps (waste) in critical business processes*
3. *Reducing the cost of poor quality*
4. *Reducing the incidence of defective products/transactions*
5. *Shortening the cycle time*
6. *Delivering the correct product/service at the right time in the right place*

A number of universities around the world have now started to integrate both Lean and Six Sigma for achieving operational excellence over the past 4 to 5 years. The first author of the article has founded the International Conference on Lean Six Sigma for Higher Education in 2013 with a clear vision to encourage wider academic community to deploy LSS. The purpose of such an international event was to share and exchange a number of research avenues on Lean Six Sigma in Higher Education. It is quite clear that several Universities in the USA (e.g.: Purdue University, Missouri University of Science and technology etc.), UK (e.g.: Heriot-Watt University, Scotland; Cardiff Metropolitan University), India (Indian Institute of Technology, Chennai, India) and Saudi Arabia (KAUST) are pursuing active research on various Lean Six Sigma topics. A number of good quality publications have already been

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produced by various authors from such institutions with a greater focus on Higher Education.

The next section of the article presents a critical review of the literature on LSS in higher education. The concept of LSS within Higher Education Institutions is still in their early stages and only a handful number of universities are currently pursuing the integrated approach of LSS as a strategy for achieving operational and service excellence.

Lean Six Sigma in Higher Education: a critical review of literature

Although a number of manufacturing and service organizations are utilizing the power of the integrated LSS methodology, it has been clear through the authors' research that the Higher Education Institutions (HEIs) are far behind in the introduction and development of this process excellence methodology (Antony et al., 2012). A number of HEIs have embarked on the Lean initiative for improving the efficiency of business processes by systematically eliminating waste (i.e. non-value added activities or steps or procedures). Examples of such HEIs are St. Andrews University (Scotland), Cardiff University (Wales), Coventry University (England), University of Portsmouth (England), Central Connecticut State University (USA), Bowling Green State University (USA), MIT (USA), and Oklahoma State University (USA), to name a few. Several studies have also been performed to measure the impact of methods, such as project based learning, to teach Lean (Kanigolla et al., 2014; Gadre et al., 2011) and Six Sigma (Kanigolla et al., 2013; Cudney and Kanigolla, 2014). Although Lean has been widely accepted by a number of HEIs, our research has shown that very few universities are integrating Lean with Six Sigma for improving the efficiency and effectiveness of university processes. An example of an HEI utilizing the Lean Six Sigma approach as the core continuous improvement philosophy is King Abdullah University of Science and Technology based in Saudi Arabia (Svensson et al., 2015). This section briefly presents some of the key findings of literature on Lean Six Sigma in the higher education sector.

Antony et al. (2012) explore the various challenges and critical factors for the introduction and development of Lean Six Sigma in a higher education context. The research first identified the challenges of applying Lean Six Sigma in a higher education setting such as the use of a vast number of tools and techniques, understanding of the process from an education system perspective, lack of awareness of benefits of Lean Six Sigma in a non-manufacturing sector, viewing Lean Six Sigma as a quick fix rather than a continuous improvement technique, lack of vision for establishing desired culture, understanding the true VOC (students), and lack of resources (e.g., time, budget). The critical success factors were explored and evaluated in the research to overcome the challenges to implementing Lean Six Sigma in higher educational institutions. The critical success factors included uncompromising top management support and commitment, effective communication at all levels, strategic and visionary leadership, project selection and prioritization, and organizational culture. The research concludes that Lean Six Sigma has a role to play, not only in industry but also in a higher education environment.

Antony (2014) identifies the readiness factors that an HEI must have in place to succeed with the Lean Six Sigma journey. The readiness factors include: i) visionary leadership for developing the desired culture for Lean Six Sigma; ii) clear

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and visible management involvement and commitment allocating budget and resources for training followed by time in completing Lean Six Sigma projects; iii) selection of the right projects using the appropriate project selection criteria; and iv) selection of top talented people in the institute for executing the projects.

Kanakana et al. (2015) designed a framework using Lean Six Sigma to improve the quality of higher education and address the different costs associated with nonconformity to process specifications in higher education. The research identified the costs for poor quality using four categories. Internal failure costs are costs associated with a student repeating a subject. External failure costs include losses such as government grant opportunities and industry funding opportunities. Prevention costs are costs for training, tutorials, mentorship, and counselling. Appraisal costs include activities such as quality audits and proofreading of documents.

Sunder (2016) provided a good commentary on different types of continuous improvement (CI) initiatives such as Kaizen, TQM, Lean, Six Sigma and LSS which are applicable to Higher Education Institutions (HEIs). He also accentuated the importance on the development of a LSS quality excellence model which would add value to all sorts of customers in HE (academics, students, industry, alumni, parents etc.), practitioners of continuous improvement and stakeholders across the university sector. Moreover, there is a need to improve the infrastructure and academic processes of universities including the curriculum design and course development processes in HEIs.

Sunder (2015) provided both academics and practitioners with an overview and the success stories of the LSS methodology adopted by a number of HEIs around the world. Various opportunities for LSS projects in HEIs are then discussed as part of the paper. Sunder also elaborates a real-time case study, explaining how LSS was leveraged to improve a university library process. The case study reduced the book search time from 15 minutes on average to less than 5 minutes on average. The project was well-recognized by the university leadership team, due to the benefits it brought into the library system.

Bargerstock and Richards (2015) have demonstrated the use of Lean Six Sigma methodology to streamline and improve efficiency of an academic assessment process. The enhanced process reduced cycle time by two-thirds, removed frustrating non-valued added activity steps, discovered additional customer value and boosted compliance rates significantly. This case study demonstrates that Six Sigma methodology can significantly improve business processes in HE settings. The authors also argued that any organisational process with inputs, outputs and feedback loops can be targeted for continuous process improvement efforts.

Anthony and Antony (2015) argue the importance of academic leadership for the development and sustainability of LSS in any HE setting. The authors define academic leadership as someone in a "position" to identify the need to allocate resources to actively manage the change, to monitor and motivate and finally deliver change within higher education, both at the institutional level and the departmental/college level. An example could be a Dean of a school realising that they are under pressure to improve performance, cut costs, and attract more research opportunities deciding to utilise Lean Six Sigma tools and techniques to fundamentally change the department both culturally and physically.

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Holmes, Jenicke and Hempel (2015) developed a framework for Six Sigma project selection in HEIs using a weighted scorecard approach. The authors in this paper have argued that more extensive research should be pursued to improve core academic processes and their framework could be used for selecting, prioritizing Six Sigma projects in such processes including assessment of courses, academic delivery processes, students' feedback processes etc. The development of such a framework for academic processes would be extremely valuable for students, academics and other stakeholders.

Research Methodology

The research methodology followed in this study was that of a case study. According to Yin (2003), "Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and the context are not clearly evident". One can distinguish a case study design separating and choosing between a single unit of analysis and multiple units of analysis. A unit of analysis in this case refers to a variety of subjects such as a program, a person, an organisation, a classroom or a clinic (Yin, 2003). For this article, the overarching unit of analysis is the case study organisation.

The primary advantage of a case study method is that it provides a detailed investigation and exploration of an event thoroughly and deeply. It has proved to be a very useful method in challenging some of the theoretical assumptions. Case study approach can help us generate new ideas and show how different aspects of Lean Six Sigma are related to one another. One of the major drawbacks with a case study method is that there are possible biases in data collection and interpretation as it is generally conducted by one person. Moreover, it is hard to generalise findings from a single case study organisation. In many cases, this approach has proved to be more time consuming than other methods of data collection.

Woodside (2010) considers a single detailed case study as a valid research methodology, principally when the study is relevant and applicable to the organisation where the research occurs. In recent times, the use of a single detailed case study has been well accepted in scholar research as a valid research method. In this particular case, a case study research methodology helps the researchers to develop their understanding of "real world" events. The case study research has proved to be a valuable method not only to test the LSS methodology and draw conclusions regarding its effectiveness but also to document and report the experiences and lessons learnt by the authors. Thus, the case study research methodology was an ideal research strategy that contributed in enriching the body of knowledge of LSS in the context of higher education.

Case study

Background to the HEI and LSS Journey

The HEI for this case study (now onwards will be referred to as University "X") is fully committed to the advancement of society through the pursuit of excellence in

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research, education, internationalisation, and knowledge exchange and through creative engagement with partner organizations at local, national, and international levels. University "X" has five campuses, and also runs distance learning programmes through 50 approved learning partners to students around the world. University "X" has established a reputation for world-class teaching and practical, leading-edge research, which has made us one of the top UK universities for business and industry. The university is a home to over 10,000 students in 150 countries around the world.

University "X" is fully committed to continuous improvement and development in all their activities. The focus is on responding to the changing needs of business, industry, and society and finding solutions to the global challenges of the 21st century. The university needs to establish clear, understandable, efficient, and effective processes and systems so that we can deliver world class experience to our students and industry, who are engaged with the university, and the stakeholders who have a vested interest in the growth of our business. As the university accelerates in the delivery of its academic strategy and its increasing collaboration with industry, there is a clear recognition that it must transform its systems and processes to ensure they are fit for a new and dynamic approach to doing business.

University "X" embarked on the LSS journey recently with the aim to build a culture of continuous improvement across the business. LSS is viewed as a methodological approach to business process improvement to increase efficiency, effectiveness, and even agility while achieving cost savings to the bottom-line of the business. The implementation was executed in two phases. The initial phase was focused on Lean Thinking to reduce waste in business processes, streamline some of the administrative and professional service processes, and eliminate some of the obvious bottlenecks which lead to process inefficiencies. The second phase was to introduce the Six Sigma methodology and Six Sigma Thinking to tackle ineffectiveness in business processes, which primarily result in defects or even failures in the eyes of customers.

Since the launch of LSS journey at University "X", over 60 staff members have attended a two day LSS Yellow Belt training course. The training was highly interactive and included many exercises and a simulation that demonstrates how waste and variation occurs in a process and, more importantly, how to use Lean and Six Sigma tools to eliminate waste and variation. LSS Yellow Belts are team members who work with a project leader (a Green Belt or Black Belt) to deliver improvements. The Yellow Belts usually work on simple continuous improvement projects in their own area of involvement; i.e., they are 'fact holders' in the process under review, they 'own' the process and work in it on a daily basis. It was important for all delegates to develop a simple business case prior to the training course. The business case included a definition of the process they intend to improve, cost-benefit analysis, impact of the problem on customers and business, potential risks, and resource requirements analysis. The scope of each project was determined prior to the course and a project champion and LSS Master Black Belt with expertise on the subject were assigned to work with each staff member to help ensure a smooth running of the project.

The LSS Yellow Belt certification provides an overall insight to the tools of Lean and Six Sigma, the key metrics of Lean and Six Sigma, and the methodologies of Lean and Six Sigma. The duration of the training program is two days and delegates are encouraged to talk about their projects during the delivery of the

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training. The Yellow Belts are expected to demonstrate a greater understanding of processes using the simple tools of Lean or Six Sigma. These Yellow Belts act as members of the Business Process Improvement (BPI) team led by a team of three or four people. As part of successful completion of LSS Yellow Belt, each staff member is expected to complete a continuous improvement project (low hanging fruit) based on the Six Sigma Define, Measure, Analyze, Improve, and Control (DMAIC) methodology and demonstrate the use of tools within the methodology. To date, a total of 25 LSS Yellow Belt projects have been successfully completed. In addition to the Yellow Belts, several staff members were trained as LSS Green Belts. The Green Belts attended a five day training course, which covered broader aspects of both Lean and Six Sigma and the power of the DMAIC in solving business process problems. Six Sigma Green Belts are employees who spend some of their time on process improvement teams. They analyze and solve quality and process related problems, and are involved with Six Sigma, Lean, or other quality improvement projects. Lean Six Sigma Green Belt training at University "X" provided participants with enhanced problem-solving skills, with an emphasis on the DMAIC model. The Green Belt has two primary tasks: first, to help successfully deploy LSS tools and techniques, and second, to lead small scale improvement projects (usually one or two) within their respective areas with the input from LSS Yellow Belts. The following are some of the characteristics of LSS Yellow Belt and Green Belt projects used within the university.

Characteristics of LSS Yellow Belt Projects:

- The project improves the performance of an existing process (e.g., identification of waste and reduction of waste using simple tools of Lean Six Sigma).
- The project utilises two or three basic tools of LSS (e.g.: 7 + 1 forms of waste analysis, process mapping).
- The project can be completed in 12 weeks.
- The project should deliver a benefit to investment ratio of at least 3:1.

Characteristics of LSS Green Belt Projects:

- The project improves the performance of an existing process (e.g., defect rate, waste reduction).
- The project attacks cycle time, throughput, etc.
- The project utilises both basic tools and some advanced tools (e.g. failure mode and effect analysis, hypothesis tests, VOC analysis using surveys and interviews).
- The project focuses on processes that affect what the customer views as valuable.
- The project can be completed in less than six months.
- The project tackles problems where the solutions are unknown to the team members and the problems are chronic in nature.
- The project should deliver a benefit to investment ratio of at least 5:1.
- The projects should have some significance to customers or stakeholders.

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Table 1 provides a sample list of projects completed by the staff members at University "X". At an institutional level, the following successes were noted in connection with LSS projects:

- Improved transparency of processes,
- Improved morale for staff members across the faculties,
- Improved cross-disciplinary working; hence, better teamwork and engagement of staff members,
- Established ownership of processes for those who have completed projects,
- Reduced operational cost and time,
- Reduced duplication of work in many departments, and
- Increased awareness of process excellence methodology for improving efficiency and effectiveness.

<i>Project Title</i>	<i>Objective</i>	<i>CTQs</i>	<i>Benefits</i>	<i>Key tools used</i>
Rationalizing scanning service processes to achieve time and quality efficiencies (YB project)	To design and implement improvements to the current scanning service to ensure delivery of required documents	Turnaround time to scan Waste in processes	28 process steps reduced to 18 Involvement of four departments reduced to one Turnaround time from receipt if request to scan reduced by over 70% Cost savings were estimated to be over £10k	Project charter Process maps SIPOC Seven wastes analysis Cause and effect analysis Histogram
Reducing the number of checks requested in Finance (YB project)	To identify the cause of check payments within Accounts Payable and investigate ways to reduce while improving the payment process	Prompt payment of invoices	Number of checks reduced from 8,000 per year to 3,500 per year. Reduced costs associated with processing and posting Reduction in staff time Cost savings were estimated to be over £3k	Project charter SIPOC Process maps Histogram Brainstorming Seven wastes analysis Cause and effect analysis
Software management and purchasing processes (YB project)	To make efficiency savings in the current process	Obtain software within five days from request being raised Provide user with appropriate download/ installation instructions	Purchasing and processing time reduced from months to five days or less Waste of £800 in staff over processing identified and eliminated Identified less expensive supplier of same goods	Project charter Process maps SIPOC Brainstorming Seven wastes analysis Cause and effect analysis

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			Cost savings estimated to be over £2k per annum	
Reviewing the Governance Structures of the Information Services Committee (ISC) meetings (GB project)	To improve the efficiency and effectiveness of the ISC meetings held at the university by the Senior Executive team	Number of meetings held each year Duration of meetings in hours Wastes in the process Number of Executives needed to make decisions	11 boards reduced to 3 19 members reduced to 6 50% reduction in the number of meetings held each year Rework and duplication wastes have been removed Meeting times reduced from over three hours to a targeted one hour Cost savings estimated to be over £22k per annum	Project charter SIPOC Process maps Seven wastes analysis Cause and effect analysis Brainstorming
Course Change Process (YB project)	To reduce the number of course changes by under graduate students in one of the schools.	Number of course changes	Reduced the number of course changes by 25% New data collection strategy have been introduced New electronic version of the forms were proposed Administrator's time to review the forms have been reduced by over four hours every week	Project charter Process mapping Seven wastes analysis Cause and effect analysis
Biometric Residence Permit (BRP) distribution process (YB project)	To utilise staff time in an efficient way during the peak enrolment period and non-peak enrolment period	Robustness of distribution process to meet UKVI (Visa and Immigration) compliance requirements Availability of effective BRP collection process for students at relevant times	Reduce the service from two people to one person at times of limited demand Enable staff on duty to complete business-as-usual tasks during quiet periods Stop providing the service at times of little or no demand Savings generated from the project is estimated to be £3000 per annum and possibly more in the forthcoming years	Project charter VOC analysis In-frame/out of frame analysis Cause and effect analysis Process mapping
Improvement of Estates services overtime management process (GB project)	To reduce overtime management within the Estates as it costs several thousands of	Extra processing time of various sorts of forms within the Estates	Reduced overproduction waste by 50%	Project charter In frame/out of frame analysis SIPOC

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	pounds per annum	Overproduction waste and other forms of waste	Reduced extra processing time by 30%; Reduce waiting waste by 20% Reduce non-utilisation of skills waste by 15 to 20% Over £25k financial savings	Cause and effect analysis Seven wastes analysis Pareto analysis
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Table 1 Sample List of projects carried out by LSS Yellow and Green Belts

Challenges in the Introduction of LSS in the Higher Education Context

This section discusses a number of challenges encountered during the development and introduction of LSS in University "X". Some of these challenges are common across a number of organizations despite the nature and size of the organization.

- There is a problem with the terminologies taken from manufacturing industry to the higher education sector (we do not make cars at the HEI).
- It is difficult to get leadership to see the opportunity and believe that the organisation can deliver the major financial improvements.
- Definition of customers and understanding their voice can be a very challenging task in a HE setting.
- The strategy of achieving leanness is not clear to many senior executives in the higher education sector.
- A lack of commitment and support from the senior executive team might promote a flavour-of-the-month attitude across the business.
- A lack of systems thinking principles across the sector can result in sub-optimization of the overall performance of some processes.
- A lean initiative should not be viewed as a quick-fix. Womack and Jones (2005) cautions that if "Lean is seen as a means of quickly cutting costs to meet budget deficits, organisations fail to achieve the real benefits".
- The culture of the higher education sector can be a big challenge in the introduction of LSS (culture of openness, trust, and acceptance).
- A silo mentality across the departments and faculties leads to poor communication across the university.
- Improvement of academic processes such as curriculum development can be quite challenging in many HEIs.
- Quantifying the impact of attributes such as subject tutors' personality traits, tutors' teaching methods, marking schemes and methods, and teaching effectiveness, among others, can be very challenging and these traits do have an impact on the quality of teaching.
- The engagement of staff members in the execution of projects can be a very challenging task especially when the projects are strategic and the processes are cross-functional.
- Sustainability of LSS in HEIs can be very challenging due to the nature of the leadership and associated culture of the sector.

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- Academic freedom and autonomy will continue to challenge the implementation of LSS in HE sector.
- Organisational barriers/constraints in the form of institutional or school policies, governmental regulations, and various unions can be quite detrimental to the execution and implementation of certain improvement opportunities in HEIs.

It is important to note that some of these challenges are critical in the introduction and development stages of the journey but some of the highlighted challenges above are more critical in the sustainability of the initiative. For instance, the sense of urgency for change is a very important success factor and it plays a critical role at the early stages of the journey and senior leaders of the Higher Education should communicate the need for change to all employees at all levels. Strategic and Visionary Leadership on the other hand is a critical factor throughout the journey of any continuous improvement initiative.

Critical Success Factors of LSS in a Higher Education Context

Critical success factors, in this context, represent the essential ingredients without which any continuous improvement initiative stands little chance of success. Each one must receive constant and careful attention from management as these are the areas that must 'go right' for the organization to flourish. The authors have identified the following critical success factors for the implementation of LSS in University "X".

Strategic and visionary leadership

Dewhurst et al. (1999) stated that leaders have the role of creating a challenging vision of the future and motivating their employees to its accomplishment. Together, the mission and vision give direction to an organization, and they function as a compass and a road map, leading to better performance. Leadership needs to enable employees at all levels to shift from their current culture to a new culture. No leadership development will succeed unless it is recognized and supported wholeheartedly by senior executives of the business (Harry et al., 2010). Leaders must provide the direction by communicating the purpose, value, and progress of the new direction and finally recognizing and reinforcing successful improvements.

The leadership team in an HEI could include the Vice Chancellor/President, Deans of various Schools and heads of departments in the colleges/Universities who have decision making power and control on organisation design, set-up, and the system. The communication about the urgency to change, need to improve processes, advantages of LSS, necessity for operational and service excellence are a few of the important aspects that the leadership team must communicate throughout the organisation. This would reinforce the quality mind-set in the universities and will set the stage to deploy LSS. According to Ramsden et al (2007) in higher education, variation in forms of leadership is experienced by lecturers and heads of departments, with an evident persistent dichotomy between authoritarian, self-interested control on one side and a collaborative but firm management on the other. Laing and Laing (2011) argue that the unique nature of universities mean a "distributed" form of leadership is required, characterised by a democratic, shared, collaborative style of leadership.

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Developing organizational readiness

Kotter (2008) suggests a failure to establish sufficient organisational readiness is why half of all continuous improvement efforts to affect organisational change are unsuccessful. It is, therefore, vital to consider whether organisations are prepared to take LSS on board through the evaluation of readiness factors (Antony, 2014). Failure to assess organisational readiness may result in senior managers and leaders spending a considerable amount of time dealing with resistance to change. The literature posits that the positive force goes into creating readiness for LSS adoption and, consecutively, there can be a significant improvement in adoption behaviour (Self and Schroeder, 2009).

When an HEI is ready to embark on the LSS journey, then a customized roadmap can be proposed to guide the organization through the implementation and deployment process. Continuous improvement maturity models provide a roadmap for many organizations to assess their weaknesses, highlight the issues that need urgent attention, and aspire to advance to a higher level in the maturity model (Bessant et al., 2001; Dale and Smith, 1997). A good understanding of the characteristics underpinning different stages of maturity models can help HEIs evaluate their own positioning in the LSS journey. The lack of sustainable, relevant, and related quantifiable results will indicate whether or not an organization is in a position to embrace the Lean Six Sigma business process improvement strategy.

Organizational culture

The culture of the business as well as the environment in which it operates can contribute to the success or failure of any continuous improvement initiative. The culture of a business has the potential to restrict change efforts or create resistance. The existing culture of the business may not be well suited to the initiative, with the implementation efforts viewed as too stark a contrast to current ways (Reger et al., 1994). Some organizations will also make unrealistic assumptions about their ability to transform beliefs and create a new culture (Powell, 1995). The external environment also has the potential to hamper efforts. For this reason, the timing of the introduction and development of the initiative is crucial and happenings out with the company must be taken into consideration.

Culture shows the behaviors of employees in an organization and strategies that can be managed in support of organizational goals. The power of Lean Six Sigma to create a culture of continuous improvement lies in the combination of changing the way work gets done by changing processes, in addition to educating people in new ways of understanding processes and solving problems. Nothing affects the culture of an organization more than the outlook and behavior of its leaders. When leaders start differentiating “noise” from “signals,” ask for what is “critical to quality,” and want to see the data that proves or disproves a hypothesis – then the culture of a business starts to change (Crom, 2010).

Project selection and prioritization

Project selection is not only the most essential but also the most challenging aspect experienced during a LSS initiative (Pande et al., 2001). Poorly selected Lean Six Sigma projects often result in the organization spending wasted time and resources

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leading to little or no improvement to the process that the project had been focused on. Some of the potential reasons for LSS project failures should be taught to all staff members who undergo LSS training. These include:

- Poor definition of the problem
- Poor project scope
- No project buy-in at the senior management level
- Projects are not aligned with the strategic goals of the university
- Team members not fully committed
- No project champions/project sponsors
- Not given enough time to work on projects
- Results or project outcomes are difficult to quantify
- Lack of data or no data available to carry out the project
- Resistance to change
- Poor existing measurement system
- Lack of resources (e.g., people, time, funding)
- Poor training or lack of training

Project selection methodologies enable organizations to deal with large volumes of proposed projects, enable comparison to be made between different types of projects, and allow one to forecast which project will give the best return (Harry et al., 2010). University "X" has used the following set of criteria for the selection of LSS projects across the University.

- Link to strategic goals of the university
- Customer satisfaction impact
- Financial payback
- Return on investment
- Resource availability
- Data availability
- Time to resolve the problem
- Difficulty in measuring the performance characteristics

For a LSS initiative to be successful and achieve long term acceptance within an HEI, the right projects must be selected (Antony, 2004). Moreover, selection of the right projects will create confidence in management and employees towards the LSS initiative.

Effective communication at all levels vertically and horizontally

When beginning a Lean Six Sigma journey within a company, everyone in all areas of the organization will need to know what is going on. The employees and all relevant personnel need to hear the purpose of the initiative, how this will benefit the company, what's in it for them, and the effect on their daily work routine. The senior management team must be honest and let all employees know there will be bumps in the road and changes to their daily routines. It is absolutely essential to explain the nature of the changes and how the company will benefit from such changes.

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One of the problems identified by the authors' is that there is no shared understanding for the purpose of a continuous improvement journey across many HEIs. Poor or lack of communication has been cited as an implementation failure for continuous improvement initiatives across a number of public sector organizations. Only through effective communication will employees be more engaged and work as a team for various problem solving scenarios. Through effective communication, organizations can establish a common language for change and improvement (Antony and Banuelas, 2002).

University "X" has used a dashboard for communicating the progress of various projects across the University. The dashboard was very helpful in understanding the stages of various projects carried out by staff members across University "X". Those staff members who were struggling with the projects were called in by the project champion, sponsor, and a LSS expert to discuss and understand the fundamental barriers to the successful execution of the project.

Key Lessons Learned

The key lessons learned come from the execution and implementation of projects across the university. There were several key lessons learned from the execution of training and mentoring a large number of LSS Yellow Belt projects.

- Taking the right measurements is a significant challenge for HEIs. Appropriate data is not necessarily readily available or indeed easily accessible from the system infrastructure currently in place. Moreover in some projects, identification of CTQs was very problematic.
- Terminologies taken from manufacturing and engineering industries are not readily accepted in the higher education sector and many people are uncomfortable using some of the more data-driven and statistical tools and techniques. From the number of projects carried out by staff members of University "X", it was found that some of the basic tools of both Lean and Six Sigma can deliver significant improvements to many business processes.
- Quantifying process improvement savings was extremely difficult without a recognized framework within higher education to point to. Efficiencies and effectiveness are not as easily measured in less "transactional" areas of the institution.
- Process improvement should consider the whole "system" if it is to be effective across any organization. The devolved nature of some HEIs creates challenges for establishing ownership of key processes and ensuring all stakeholders are active participants in improvement activities.
- The existing culture of the higher education sector is a significant challenge to the introduction of LSS. In order for staff to feel they are part of the organization and openly talk about their improvement suggestions, there needs to be a culture of openness, trust, and acceptance.

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- Most of the projects carried out by staff members were at the operational level. The next stage of the initiative was to take up more challenging strategic projects, which are more aligned with the goals of University "X".
- The absence of a LSS deployment champion at the University level caused a number of issues. For sustainability of a process improvement initiative such as LSS, it is critical to have a dedicated LSS deployment champion who can report directly to the executive team of the university about the progress and the nature of strategic projects that can deliver significant improvements to the bottom-line of the business.
- There was no formal reward or incentive system in place. This is something University "X" should consider in the forthcoming years as this is quite essential for staff engagement and participation to make a positive difference to the existing culture of the organisation.

Conclusions, Limitations and Agenda for Future Research

Lean Six Sigma can be a very powerful methodology for tackling process inefficiency and ineffective problems in the higher education sector. However, this powerful methodology has not yet been widely adopted by many universities and colleges due to the pure misconception that it is only meant for manufacturing companies. Higher Education Institutions can make use of LSS for tackling efficiency and effectiveness of business processes across the sector. This paper presents the LSS journey of a HEI based in the UK. One of the major limitations of this research is that it is a single case study and therefore the findings are not generalizable and cannot be replicated. Moreover, a case study can be executed in more than one manner and there is no standard approach to it. The authors would also like to highlight the fact that the findings of the study are based on the views of a few people involved in the case study and therefore the conclusions drawn from the study can be viewed as quite subjective. Most of the projects executed by staff members in University "X" were focused on process and quality related problems in Administration, Finance, Human Resources, and Estates. The next stage would be selecting and prioritizing projects within some of the academic processes such as marking, curriculum development by academics, delivery of high quality teaching, and innovative teaching methods. The paper also presents the challenges, success factors, key lessons learned, and sample projects executed at University "X" as part of the LSS journey. The agenda for future research involves three separate components. The first component should be focused on the development of a LSS tool kit for the HEIs. One of the critical success factors for the successful deployment and sustainability of LSS in any organisational setting is the strategic and visionary leadership. However recent research has indicated that there are some commonalities and critical differences between industrial and academic leaderships. The authors would like to set an agenda to critically assess the impact of academic leadership on successful deployment of LSS in HEIs. The final component should be focused on the development of a LSS Readiness Index Model to measure and understand the level of readiness of a HEI before they spend their time

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and effort into LSS or any form of continuous improvement initiative. The authors are also keen to develop a customised curriculum for LSS Green Belt and Black Belt training in the forthcoming years as this would help a number of HEIs to understand the contents of the training that are more suited to the education sector. The criteria for the successful completion of LSS projects in HE settings also need to be explored further through empirical research. The results of the projects, the key lessons learned from the projects, challenges encountered during the journey and success factors will be proved to be of immense value to other HEIs and leading academics who are currently going through similar journey of continuous improvement.

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